# GREENLAND RESEARCH AND DEVELOPMENT PROGRAM

## U.S. ARMY ENGINEER ARCTIC TASK FORCE

# 1957 AFTER OPERATIONS REPORT



ARTMENT OF THE ARMY

PS OF ENGINEERS

1 NOV 1957

# AFTER OPERATIONS REPORT
# GREENLAND RESEARCH AND DEVELOPMENT PROGRAM, 1957

## PREFACE

The authority for the 1957 Corps of Engineers Research and Development Program in Greenland is contained in letter from the Office of the Chief of Engineers, ENGNB, subject: "Authority for Chief of Engineers R&D Program in Greenland—Summer 1957," dated January 1957.

The U. S. Army Engineer Arctic Task Force was the coordinating, supervising, and supporting organization for the research and development projects in Greenland. Scientists and technical personnel were from five research and development agencies: the U. S. Army Engineer Research and Development Laboratories (USAERDL), Fort Belvoir, Va., the U. S. Army Snow, Ice, and Permafrost Research Establishment (USASIPRE), Wilmette, Illinois, the U. S. Army Engineer Waterways Experiment Station (USAEWES), Vicksburg, Miss., the Arctic Construction and Frost Effects Laboratory (ACFEL) of the U. S. Army Engineer Division, New England, Corps of Engineers, Boston, Mass., and the U. S. Army Electronic Proving Ground (USAEPG), Fort Huachuca, Arizona.

Other technical services of the Army contributed greatly to the program. Invaluable support was furnished by the Medical, Signal, Transportation, and Quartermaster Corps. The U. S. Air Force gave a great deal of assistance at Thule and Narsarssuak Air Bases, supplying flying missions and logistical support.

## CONTENTS

## I. INTRODUCTION

1. This report outlines the general accomplishments of the 1957 Corps of Engineers Research and Development Program in Greenland. This was the fourth and most extensive year of the Greenland program since its inception in 1954.

The 1957 program consisted of 27 separate projects. These were studies of the elements of engineering in regions of snow, ice, and permafrost. In conjunction with previous years' programs they have, to a large measure, demonstrated the feasibility of many phases of polar engineering.

## II. SCOPE

2. The scope of the 1957 program is outlined in the Conference Notes on the 1957 Corps of Engineers Greenland Research and Development Program. These notes are based on the Consultants Conference held at Office, Chief of Engineers, 17-18 January 1957.

The program was accomplished as described in Section V of this report. Complete reports of project activities and results will be published by the respective agencies.

A summary of logistical support data on organic Task Force operations is contained in Section VI of this report.

## III. ORGANIZATION AND MISSION

3. The organization of the U. S. Army Engineer Arctic Task Force is shown in Figure 1. The mission of the Task Force is:

*a.* To provide command and staff supervision, coordination, and planning for engineer research and development agencies' operations in isolated arctic regions.

*b.* To provide administration and logistical support, communications, maintenance, and required military skills for research projects operating under Task Force control.

The organization of research and development agency personnel, attached to the Task Force in the field in 1957, is shown in Figure 2. The mission of the research and development agencies is to accomplish the project work as programed in the Conference Notes referenced in Section II.

## IV. CHRONOLOGY

4. The U. S. Army Engineer Arctic Task Force moved from Fort Belvoir, Virginia, to Northern Greenland in five increments during the period 14 March — 29 April 1957.

Research and development projects were active in field work from 15 April to 9 September 1957. The locations of the camps which were operated to support these projects are shown on the map in Figure 3.

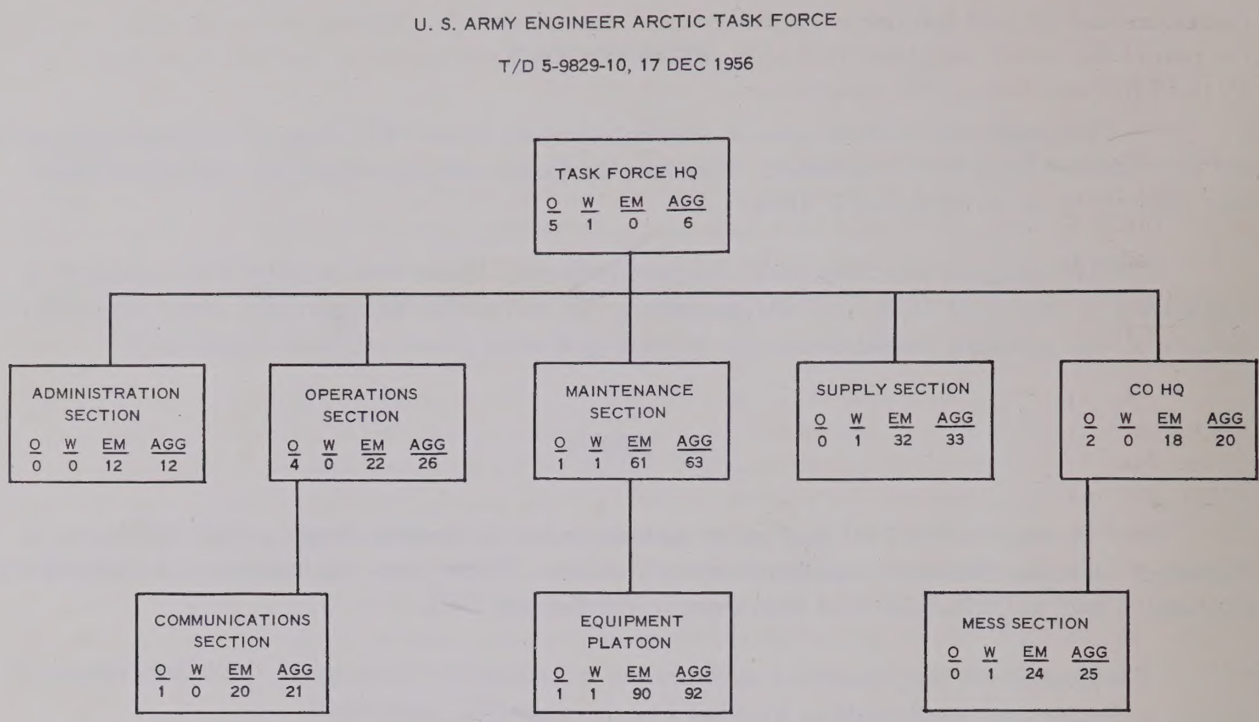


**Figure 1. U. S. Army Engineer Arctic Task Force organization.**

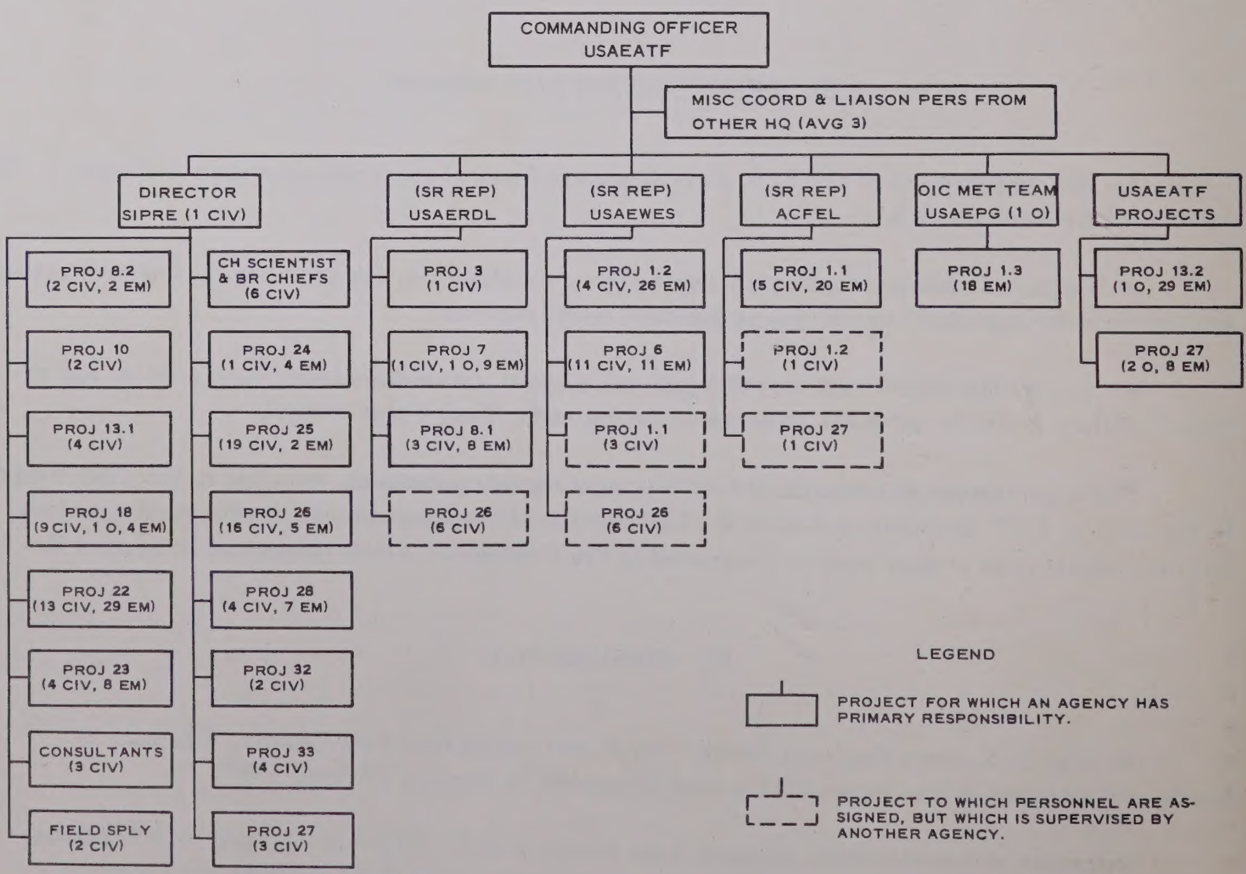


**Figure 2. Project organization, 1957 Greenland R&D program.**


Figure 3. U. S. Army Engineer Arctic Task Force camps, 1957.

The Task Force returned to Fort Belvoir, Virginia, in four increments during the period 17-21 September 1957.

## V. PROJECT ACTIVITIES

Main projects.

5. Actual project results must await evaluation and interpretation of data to be published in final reports by the agencies concerned. The following information, however, indicates the degree to which objectives were realized:

*Project 1.1 — Approach Roads (USAEWES/ACFEL. Project Leader: Prof. F. J. Sanger, ACFEL).* Additional berms and one crushed rock test section were constructed on the ramp road. The survey of movements and performances of previous years' construction was continued. Berms were in four 500-ft sections, 1 ft thick, between stations 83 and 93 on the ramp road. One pair of berms was 10 ft wide and the other was 20 ft wide. The crushed rock test section was 20 ft wide by 700 ft long with one section 12 in. thick and the other 6 in. thick. The section was constructed parallel to the ramp road on the northern side at station 70. Accelerated traffic tests failed it rapidly. Increased maintenance work was required on both the transverse and ramp roads owing to continued perching of the road. Twenty-five thousand cubic yards of fill were placed in this maintenance. The transverse road was extended to the tunnel portal, where a 75- by 300-ft level pad was constructed.

*Project 1.2 — Core Drilling in Permafrost (USAEWES/ACFEL. Project Leader: Prof. F. J. Sanger, ACFEL).* A total of 24 drillings were made, 16 of which were from the ice surface on the TUTO ramp. Of the latter, two corings were continued down into the permafrost. Inclinometer tubes were installed in 11 of the holes in ice. Considerable difficulties were met in the inclinometer program; improvements found desirable from the summer's experience will have to be made in order to obtain successful results. Part of the drilling program was coordinated with Patterned Ground Studies, Project 18, but it was not possible to obtain good cores from the coarse-grained material encountered due to loss of drilling fluid. Five successful holes were drilled in large ice masses in patterned ground.

*Project 1.3 — Meteorological Stations (USAEPG. Project Leader: 1st Lt. R. C. de Wilde, SigC, EPG).* Three stations were established and operated as planned. Because of the late arrival of thermocouple wire, recording potentiometers, and one Rawinsonde component, certain data could not be collected until late in the season. These data included temperatures at various levels in air and ground, and solar radiation measurements.

*Project 3 — Snow Compaction (USAERDL).* No field work was conducted. All snow compaction equipment was returned to TUTO for possible modification during the 1958 program.

*Project 4 — Pipeline and POL Storage (USAERDL).* No field work was conducted. All project equipment was returned to TUTO for more adequate storage.

*Project 6 — Trafficability (USAEWES. Project Leader: Mr. A. A. Rula, WES).* Extensive tests were conducted to provide data for determining the trafficability of vehicle tracks and sled runners on Greenland ice-cap snows. These tests supplemented the 1955 work which was conducted on wet, coarse-grained snows. Vehicles were tested for maximum drawbar pull, track slippage, rolling resistance, and rut depths over a wide range of dry, fine-grained snow conditions.

Towing resistance of sleds was similarly tested. All tests were accompanied by collection of data on snow properties before and after passes, and on meteorological conditions.

*Project 7 — Trail Marking (USAERDL. Project Leader: Mr. H. P. Van Eckhardt, ERDL).* Trail wire power installations and new simplified receivers were tested by several swings on the TUTO-Site II trail. Numerous wire breaks, buried to depths of 16 ft, had occurred in the marginal zone since the previous summer. The only practical recourse was to lay new wire between miles 4 and 32, which was accomplished. Terminal power equipment was installed in the new undersnow camp at Site II, in addition to equipment at Camp TUTO. No significant difficulties were encountered with equipment, but the many operational difficulties pointed to the need for a reevaluation of the trail wire concept. In effect, the maintenance effort required outweighed the operational advantage obtained.

*Project 8.1 — Crevasse Detection (Electronic Method) (USAERDL. Project Leader: Mr. M. L. Olds, ERDL).* The modified electrode-type crevasse detector was thoroughly tested and widely used during the entire season. Successful tests were made with the so-called Y- and W-systems. The W-system proved more generally successful especially as to maneuverability, safety of operation, and the pinpointing of crevasse edges. The Y-system tended to give a more positive indication of crevasses with very deep snow bridges, but did not give indication of a crevasse until the vehicle tracks were at the very edge. Although it was not possible to operate both systems simultaneously, it was possible, with slight modifications, to switch from one system to the other without difficulty on the same vehicle. The successful employment of the detector by several soldier-operators proved its operational readiness.

*Project 8.2 — Crevasse Detection (Radiometer Method) (USASIPRE. Project Leader: Mr. B. L. Hansen, SIPRE).* Tests were conducted in Blue Ice Valley with three different radiometer mounts: on top of a weasel, from an L-20 aircraft, and on top of a 100-ft steel tower. Warm weather caused snow to begin melting even before testing started on 15 May. This created a condition of extremely small temperature differentials between the snow surface above a crevasse and the adjacent snow surface, giving minimum or no-signal radiometer indications. It will be necessary to make observations at a later date under different conditions to achieve the objectives desired.

*Project 10 — Ramp Studies (USASIPRE. Project Leader: Dr. T. M. Griffiths, University of Denver).* Accumulation, ablation, and moraine information was gathered in a continuation of the previous three years' observations. Location of the ice tunnel was tied into the existing TUTO control base line. The ice tunnel center line was also located, surveyed, and marked on the surface above the tunnel. Although the primary objectives were realized, the project was severely hampered by bad weather. It is of great credit to the two contract scientists that so much was accomplished under the adverse surveying conditions.

*Project 13.1 — Snow Structures (USASIPRE. Project Leader: Mr. R. W. Waterhouse, SIPRE).* Project work consisted of consultation on and instrumentation of the new undersnow camp, studies of the year-old experimental runway sections, development of additional snow laboratory testing equipment, measurements of long-time pressure and deformations, and related studies of the physical properties of snow. The consultation given during the design and construction of the undersnow camp permitted the incorporation of several experimental features. Instrumentation was installed throughout the installations to determine performance of designs as well as to furnish additional research data on the behavior of snow. Instrumentations

included: level controls throughout the floor and roof systems; deformation gages for all foundations; and temperature measurements throughout the installation and the adjacent snow.

*Project 13.2 — Undersnow Camp (USAEATF. Project Leader: CWO W. E. Palmer, EATF).* An undersnow camp was completed with a capacity to support 150 persons. Jamesway huts were erected to billet approximately half of this capacity in the undersnow installation, with provisions made to erect abovesnow structures as additional billets are required. Construction consisted of excavating trenches with a "Peter" snow miller, and roofing with various types of experimental roofs and roof trusses. The roofed trenches included: two 600- by 20-ft trenches for Jamesways, one 100- by 16-ft POL storage trench, one 156- by 16-ft power plant trench, an 80- by 20-ft heavy vehicle maintenance trench, and a 30- by 20-ft shop van trench. Connecting passageways consisted of 8-ft-wide trenches with roofs formed of disaggregated snow blown from a Peter snow miller onto removable forms. The entire camp was built by Engineer soldiers from standard troop supply construction materials. In addition to billets, the installed facilities included: kitchen, dining hall, snow melters, hot and cold water systems, a 150-kw power plant, 7000 sq ft of covered storage space, a recreation hall, a third echelon Engineer and Ordnance equipment maintenance shop, a dispensary, radio communications, and latrine facilities consisting of toilets, showers, lavatories, and laundry. The on-site construction effort was the equivalent of approximately 50 platoon-days. The camp has a life expectancy of 3 years dependent upon snow accumulation and the results of the inherent experimental features.

*Project 18 — Patterned Ground Studies (USASIPRE. Project Leader: Dr. A. E. Corte, SIPRE).* The investigations of patterned ground phenomena were continued, especially as related to the reconnaissance for identification of permafrost, the occurrence of and action of ground ice masses, and the nature of vegetative cover. Field work was divided into five phases: geophysical exploration, trenching of the active layer and permafrost ice, ground ice crystallography, ecological studies, and experiments with different layers of gravel over varying surfaces of melting ice. The experiments with gravel layers on melting ice surveys produced correlation with several natural patterned ground actions.

*Project 22.1 — Ice Tunnel (USASIPRE. Project Leader: Mr. D. O. Rausch, Colorado School of Mines).* The ice tunnel was enlarged to 12 by 7-1/2 ft and extended to a total length of 1170 ft. Two large rooms were excavated, one 33 by 104 ft and the other 21 by 100 ft, both with an average height of 7-1/2 ft. The method of excavation was to cut the ice with a Joy 10 RU standard coal cutter and then to break it into fragments by blasting. Broken ice was hand-loaded into cars of a battery-powered locomotive. The speed and relative ease of making excavations with mechanized equipment were most promising. The rate of excavating was approximately 200 cu yd per day with two 15-man shifts. Progress in the main tunnel was seriously hampered near the end of the season by the presence of large amounts of moraine-bearing strata, demonstrating the need for pretunneling coring investigations.

*Project 22.2 — Deformation and Strength Measurements of Ice Tunnel and Ramp Ice (USASIPRE. Project Leader: Mr. T. R. Butkovich, SIPRE).* Deformation, strength, and other physical properties of tunnel and ramp ice were measured. The rate of closure deformation in the tunnel was found to depend not only upon overburden but also upon the type of ice — particularly the latter. Five distinct types of ice were identified within the tunnel, complicating the task of determining the physical properties of tunnel ice. The minimum rate of closure in the tunnel was approximately 3 per cent per year at about 125 ft from the portal.

*Project 22.3 — Mapping of Ice Tunnel Structural Features (USASIPRE. Project Leader: Dr. L. H. Noble, SIPRE).* The metamorphic structures exposed in the tunnel were mapped in detail. These include shear planes, blue bands, foliation, lineation, and dirt bands. Important

formations and all grid stations were photographed for later study. Studies of the dirt bands toward the rear of the tunnel suggested that at least part of these bands might be avoided at an elevation 20 to 50 ft above that of the present tunnel.

*Project 23.1 — Whiteout Studies (USASIPRE. Project Leader: Mr. H. E. Reiquam, SIPRE).* The 1957 season was quite unfavorable for the study of fog-type whiteouts since very few occurred at the Site II altitude. Relatively high temperatures accompanied each fog which did occur, making it impossible to make further tests of the silver iodide dispersal technique. Quantitative data were collected, however, on visibility, humidity, and the nature of suspended particles, supplementing previous years' research.

*Project 23.2 — Snowdrift Studies (USASIPRE. Project Leader: Mr. R. G. Baughman, SIPRE).* Seventeen experimental snow fences were erected in a pattern expected to produce a drift accumulation about 1800 ft long, 250 ft wide, and 5 to 6 ft above the expected snow surface of summer 1958. The individual fences were oriented normal to storm winds, with fences staggered so that a line through the center of all fences was parallel to prevailing winds. All fences were of the paper-strip type. Strong winds tore the paper in several of the test sections. Various erection methods were used in order to determine the most practical method of construction and removal. A 10,000-ft fence pattern was not erected because of the need for further testing prior to construction of a prototype elevated runway.

*Project 24 — Ice Cliff Studies (USASIPRE. Project Leader: Mr. R. E. Hilty, SIPRE).* A final resurvey was made of instruments of the ice cliff formations at the Red Rock Lake site. The camp was occupied for 16 days during which excellent weather permitted accomplishment of virtually all project objectives. The warm weather, however, produced rapid melting of the ice face above the tunnel making completion of all of the tunnel surveying unsafe. Data collected will provide another year of record of glacier activity, including movement, ablation, calving, tunnel deformation, temperatures, and general weather conditions.

*Project 25 — Ice-cap Drilling Techniques and Core Studies (USASIPRE. Project Leader: Mr. G. R. Lange, Mr. C. C. Langway, and Mr. E. J. Kolb, SIPRE).* The deep drilling and coring project consisted of three parts: the techniques of ice-cap drilling and coring operations, the studies of the core samples, and the collection of data from drill holes after drilling. A new hole was cored to 1000 ft and alternately drilled and cored from 1000 ft to a final depth of 1348 ft. The hole was cased to a depth of 152 ft where loss of drilling fluid (cold, compressed air) became negligible. Core examination included logging, packaging, and determinations of density, grain size, stratigraphy, fabric analysis, entrapped air pressure, and strength. Many cores were returned to the laboratories in the United States for deuterium content analysis, bacteriological analysis, and further study of physical properties. Drill hole measurements included temperature profiles and deformations of the 1956 as well as the 1957 holes. At the end of the season all drilling equipment was returned to Camp TUTO.

*Project 26 — Explosives in Ice (USASIPRE, USAERDL, USAEWES. Project Leader: Mr. C. W. Livingston, Barodynamics, Inc.).* Research was accomplished on the effects of impact and explosions in and on ice. Blasts ranging from 2-1/2 to 40 lb of each of four different types of explosives were detonated at various depths below and in the air above the surface of ice. Measurements were taken of air-blast pressure, underice shock pressure, fly rock travel, and crater dimensions. A total of 130 test shots were fired. When analyzed, the data collected will permit the correlation of explosives effects in ice and other media, the development of criteria for protective design, a comparison of the effectiveness of various types of explosives in ice, the determination of the relations between shock pressures and crater dimensions, and the determination of the parameters in the general explosives-effects equations.

*Project 27—South Greenland Road Survey (USAEATF, ACFEL, USASIPRE. Project Leaders: Lt. G. E. Anderson, EATF; Mr. C. F. Fulwider, ACFEL; and Mr. R. D. Leighty, SIPRE).* A road route was reconnoitered and surveyed in detail from Narsarssuak Air Base (BW-1) to a suitable ice-cap access ramp and trail route terminus. The geophysical reconnaissance and the route survey indicated that a Southern Greenland ice-cap access is very practicable. The road distance from the air base to the ice edge totaled 47 miles. An ice-cap ramp road would not be required. The three isolated field parties were supported by an attached Transportation Corps aviation detachment which gave inestimable and exemplary support. The two H-34 helicopters flew a total of over 235 hours.

*Project 28—Airphoto Research (USASIPRE. Project Leader: Mr. R. E. Frost, SIPRE).* A performance survey was made of several of the installations at Thule Air Base in order to provide a measure of success and reliability of the air-photo techniques used in the original site selection survey. Another phase of the project was research on specifications required to obtain quantitative and qualitative air-photo data from ground or snow photographs. The work on specifications was mainly in connection with the thermodetection device of Project 8.2. Research included measurements of color temperatures as a function of time of day, sun angle, and weather conditions. Comparisons were made of different kinds of color film and different selective filters under various surface conditions.

*Project 31—Research on Submerged Skis (USASIPRE).* No field work was conducted.

*Project 32—Instrumentation and Measurement of Ice-cap Sites (USASIPRE. Project Leader: Mr. B. L. Hansen, SIPRE).* Only limited observations were made this season owing to the abandonment of the installations at Site I and Site II. Data collected at Site II included pressures, temperatures, settlements, and melting. Project personnel also consulted on the design and instrumentation of the undersnow camp, Project 13.

*Project 33—Pile Testing (USASIPRE. Project Leader: Mr. N. C. Costes, SIPRE).* These tests were a continuation and augmentation of the work performed by the Metcalf and Eddy and Alfred Hopkins and Associates personnel in 1956. The two piles installed in 1956 were tested to failure, and loading-settlement, unloading-rebound, and subsequent reloading-settlement data were obtained. Uplift tests were also made. A series of tests were made at the same site to determine pile bearing capacities as a function of depth, density, and repetitive loading. Another series of tests was conducted to determine the influence of pile size on the load-deformation characteristics of a snow layer acted upon by a pile of constant unit load. Observations and measurements were made of the pile foundations constructed in the undersnow camp, Project 13.2. Supplementary data taken during all tests included: densities, unconfined compression strengths, temperatures, and Rammsonde hardnesses.

**Other projects.**

6. *Williams Hole Digger (USAEATF).* The 5-ft-diameter Williams Hole Digger (auger) was tested in ice on the TUTO ramp. The equipment performed excellently. A 70-ft hole was dug in 4-1/2 hours, at an average rate of about 4 min per ft. The rig was difficult to move from place to place, and definitely requires well-designed runners and outriggers if movement over snow is ever required.

*Snow Boat (USAEATF, USAERDL).* A propeller-driven snow boat was tested near the end of the season. This boat had been previously used successfully as a water boat on the Potomac River at Fort Belvoir. On snow it performed quite well and was capable of attaining speeds of approximately 25 mph, but was exceedingly rough to ride and had a tendency to freeze down when

stopped for even a few minutes. Fuel consumption was also excessive.

*LGP Tractor Modification (USAEATF).* Task Force maintenance shops were very successful in an attempt to increase the performance of the basic oversnow prime mover, the low ground pressure tractor. A turbocharged Caterpillar 337 engine was installed in an LGP D-7 tractor, resulting in the doubling of both speed and drawbar pull in sustained operation. Recommendations for the improvement of the LGP D-8 tractor will be submitted at a later date. Such tractor modifications, in conjunction with the use of plastic-coated sled runners, represent potentials for greatly increasing the efficiency of oversnow logistics.

*Photographic Coverage (USAEATF, USASIPRE).* The attached Signal Corps cameramen obtained extensive motion and still picture coverage of all Task Force and project activities. Coverage of USASIPRE projects was performed under contract by that agency. To avoid duplication, the entire photographic effort was coordinated by a representative of USASIPRE. Approximately 50,000 ft of color motion picture film and 648 each still photographs were exposed.

## VI. SUMMARY OF SUPPORTING OPERATIONS

7. The magnitude and diversity of the 1957 program greatly increased Task Force responsibilities for command supervision, logistical support, equipment maintenance, camp construction and operation, and ice-cap swing operation.

Particular emphasis was given to safety, sanitation, supply economy, and detailed project support. One serious accident was incurred, in which a man lost three fingers on a construction job. The influenza epidemic which seriously affected all neighboring organizations was avoided by careful quarantine and sanitation measures. The objective of constructing proper warehouses and open storage facilities was virtually completed, immeasurably improving supply economy. Project support was believed successful by virtue of the increase in camp facilities, the early and careful programing of necessary supplies and equipment, and the assignment, in most cases, of a high caliber of enlisted personnel.

In addition to the TUTO base camp, five other camps were operated for close project support. Three of these camps were located in the marginal zone of the ice cap, supporting one to two projects each and a total of about 50 personnel. A fourth small camp at Red Rock Lake, some 40 miles northeast of Thule Air Base and accessible only by helicopter, was manned by up to five men for approximately a month. The central ice-cap camp at Site II was operated for the entire season, supporting a maximum of 120 persons and 12 projects. Camp TUTO itself housed approximately 480 personnel and accommodated nearly 100 visitors. The Task Force maintained no offices at Thule Air Base, although a 6-man detachment was kept there for necessary supply and transportation liaison.

Supply activity was greatly increased over any previous year. Shipments from the United States totaled 3500 short tons, of which 500 tons were air freight. Supplies moved from Camp TUTO to ice-cap camps, principally Site II, totaled approximately 1100 tons. These supplies included miscellaneous agency items but were primarily the end product of the programing and administration of the $670,000 FY 1957 Task Force funds.

Equipment maintenance and operation represented approximately one-fourth of Task Force resources. Major items of equipment included low ground pressure tractors for ice-cap camp support, large trucks and cranes for cargo handling, construction equipment capable of moving approximately 1000 cu yd of earth per day, and a fleet of 40 jeeps and 30 weasels. Many miscellaneous and specialized items of equipment, such as a total of 45 gasoline and diesel

generators, were serviced by the Maintenance Section.

Construction work consisted of earthwork and theater-of-operation types of building construction. Fifteen miles of existing roads were maintained, and in several areas relocated. Nonfrost-susceptible fills were placed for all new buildings and for 15,000 sq ft of open storage pads. Random fill material was placed for over 50,000 sq ft of additional storage and work areas. Building construction consisted of the erection of Jamesway-type huts and lumber-sheet metal buildings. Additional construction at TUTO included a kitchen and dining hall, a shower-laundry building, a heavy shop building, the erection of 30 double Jamesways, and the conversion of the old mess hall to a warehouse. Most of the structures for the new undersnow camp at Site II were prefabricated at TUTO prior to shipment to the site.

The operation of heavy ice-cap swings was necessary in order to supplement the capabilities of the Transportation Arctic Group. Task Force swings transported approximately 700 short tons of freight and 123 passengers, primarily to Site II, equaling over 120,000 ton-miles and 20,000 passenger miles.

## VII. COMMANDER'S SUMMARY

8. The 1957 season is considered to have been the most successful experienced by the Task Force in Greenland to date, both from the research and development and from the operational points of view. This success stemmed largely from three factors: the continuity of personnel which has been maintained in the Task Force in certain key officer and enlisted positions; the high caliber of replacement enlisted personnel recruited during the previous winter; and the careful prior planning and programing during the previous year by both the Task Force and the research agencies.

Relationships between soldiers and civilians were excellent. A spirit of cooperation, mutual understanding, and devotion to duty prevailed among all personnel throughout the entire season.

Elmer F. Clark

ELMER F. CLARK
Lt. Colonel, CE
Commanding

Date Due

| | | | |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

Pam.001.891: (*2) 1957
U.S.Army Engineerr Arctic Task Force.Corps of Engineers.
Greenland Research & Development.

Program. 1957 after operations report.